



Wind tunnel Design for Lunar Dust Filtration Tests

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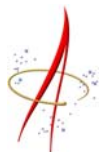
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Overview

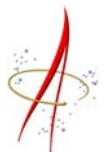
NASA's vision is to eventually establish human stations on the moon. As a result, scientist need to test different air circulation and filtration systems to make such efforts possible. The additional loading of lunar dust will challenge future exploration filtration systems. A filtration testing facility is being set up to test filters and filtration concepts for the removal of lunar dust particles.





Project Scope

- ASHRAE and Livermore standards to establish regulations for future filtration tests.
 - Gain insight on leak tests, sampling considerations, and how to characterize the airflow.
- Identify which probes were needed and contact companies to purchase them.
- To start initial CAD designs
 - Use designs to finalize probe placement and dimensions.





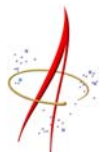
Dust Properties



Astronaut Gene Cernan covered in lunar dust.

Lunar Dust

- Fine and Ultra fine Particles
- Abrasive
- Inhalation causes biological problems
- Causes increased level of maintenance and mission risk





Filtration Standards

ASHRAE Standard 52.2

Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

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Lawrence Livermore National Laboratory

HEPA Filter and In-Place Leak Testing Standard

Lawrence Livermore
National Laboratory





ASHRAE 52.2

4.42 Criteria for Sampling The portion of the sampling line in the duct area shall block less than 10% of the duct cross sectional area.

Combined particle loss should not exceed 50% (based on 10 μm dia. KCl)

5.9 Test Duct Air Leakage Test

Air leakage from the test duct shall not exceed 1% of the total airflow rate.

6.3 Final Filter

Capture any test dust that passes through the test device in a final filter that shall be one of three forms:

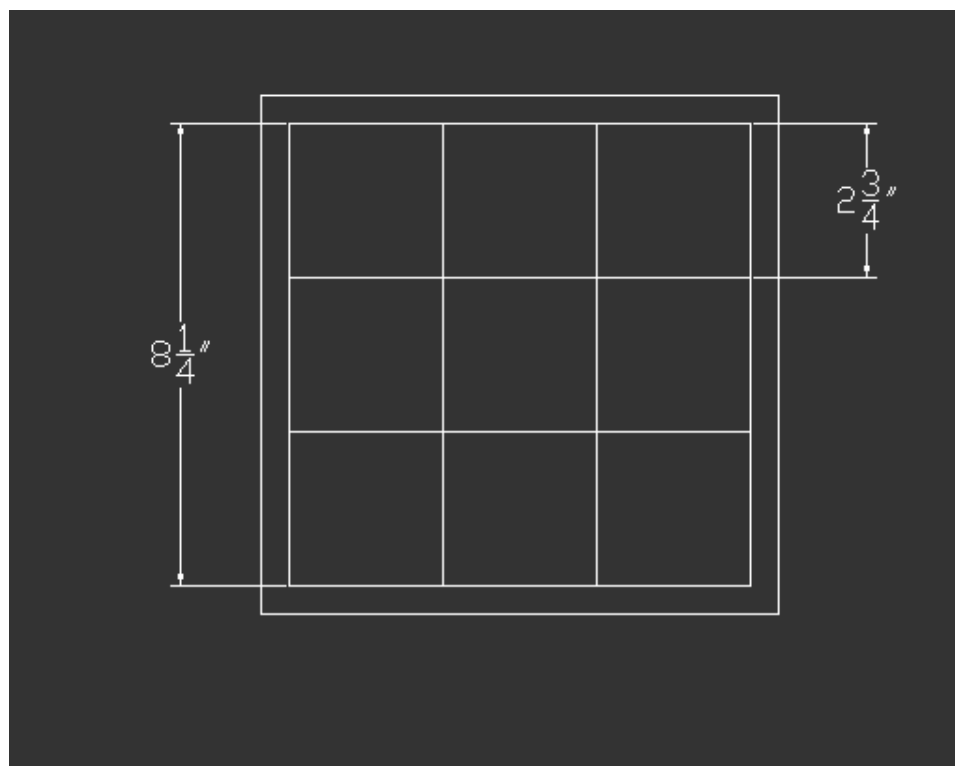
- » Flat sheet of filter media, clamped between sealing flanges
- » Filter media shall be inserted in a holding frame that permit the use of more media than the duct cross section.
- » A disposable Cartridge filter.





ASHRAE Standard 52.2

Sampling grid with nine equal-area points for measuring the uniformity of the air velocity and aerosol dispersion.





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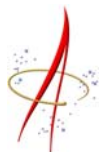
Uniform Aerosol Concentration Using Duct Length

5.2.1 Adequate duct length is required to allow the air velocity and the aerosol concentration to become uniformly distributed. This is ensured by placing the **downstream sampling location >7.5 duct diameters** from closest source of turbulence.

Acceptable Criteria for In-Place Leak Test

6.1 HEPA filters are acceptable if the percent leakage is equal or less than **0.03%** or the value is less than 0.05%.

If the in-place leakage exceeds 0.03% and cannot be adjusted by correcting the sealing clamps, the HEPA filter shall promptly be replaced.





CAD Design

FEATURES OF FACILITY

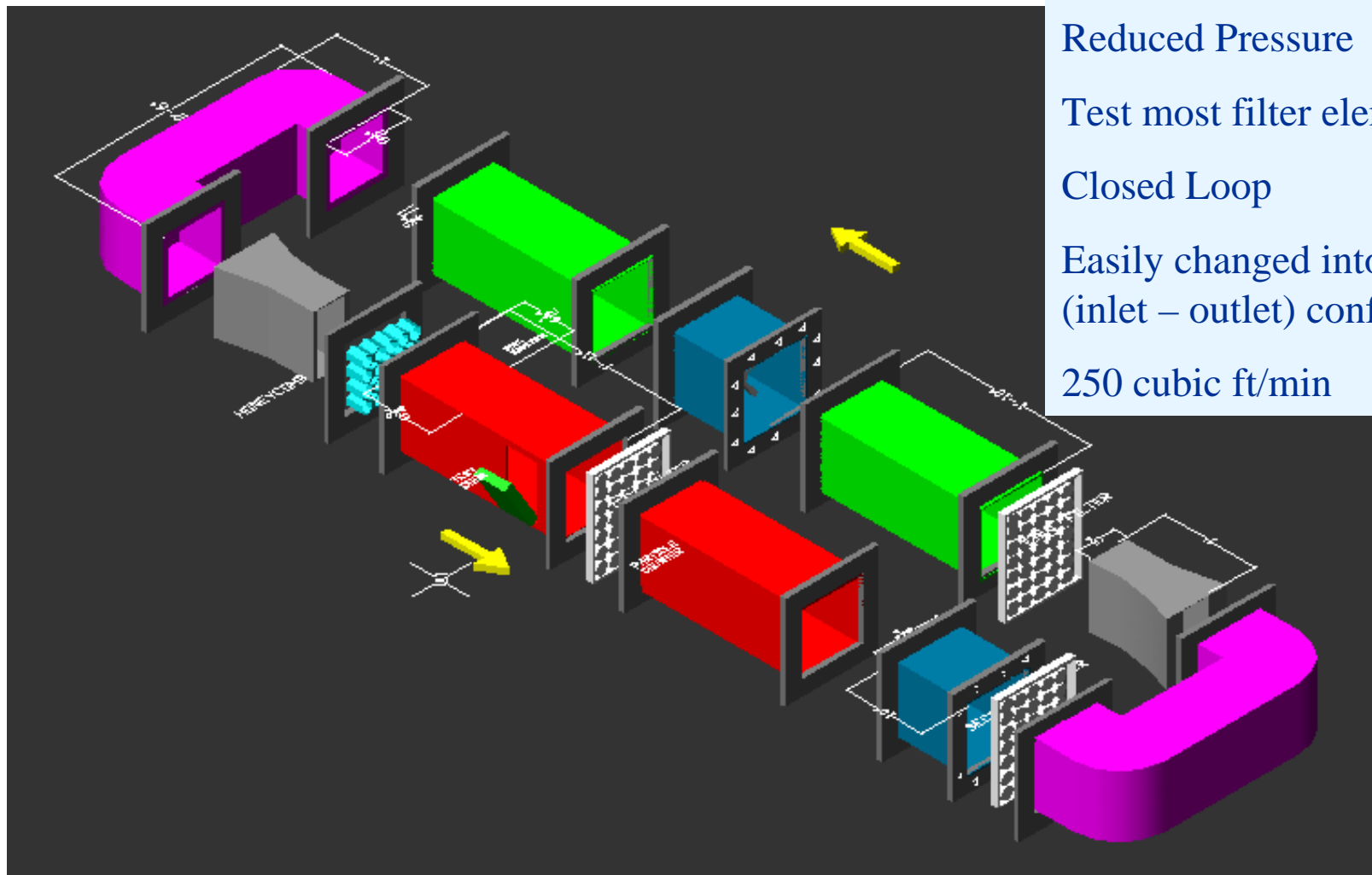
Reduced Pressure

Test most filter elements

Closed Loop

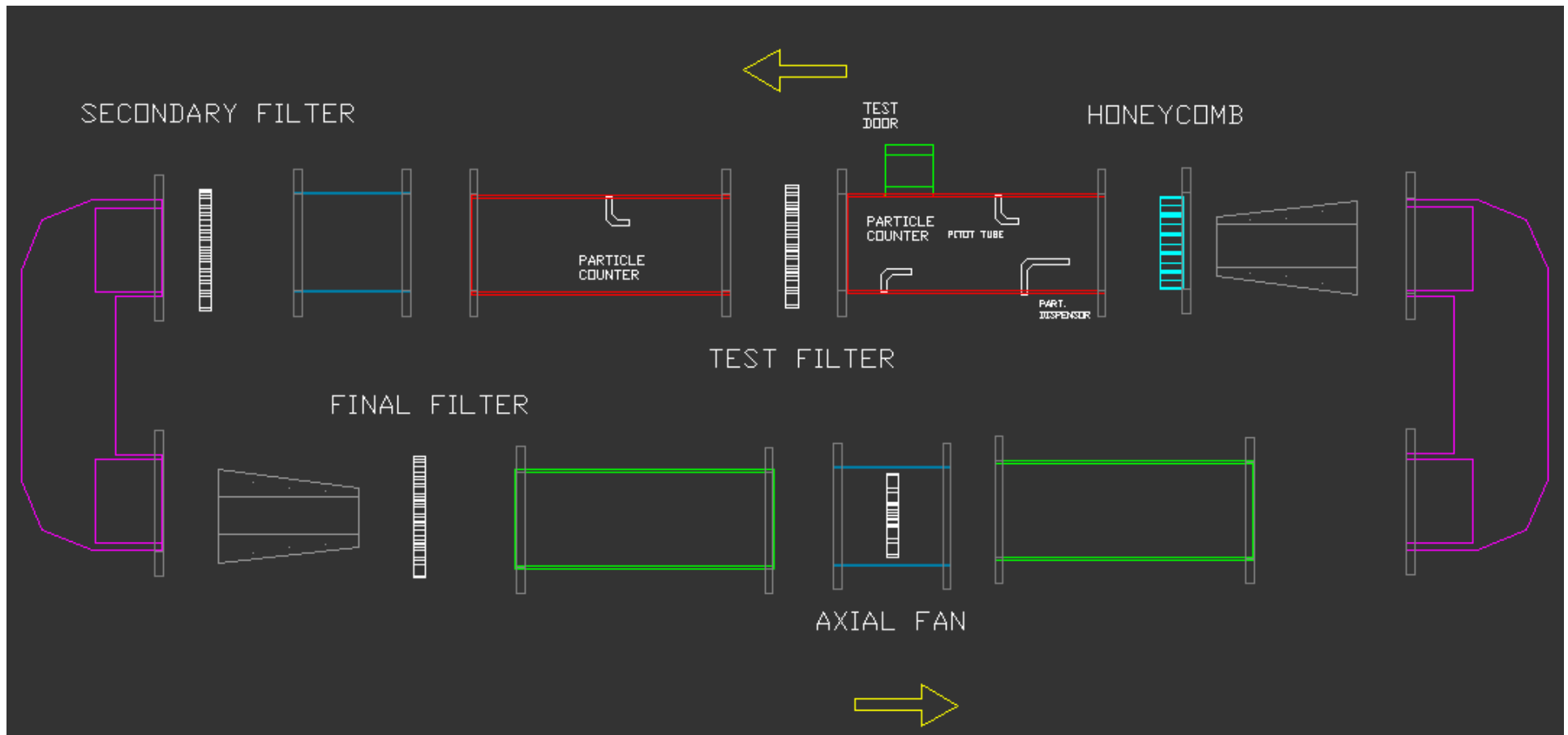
Easily changed into open
(inlet – outlet) configuration

250 cubic ft/min



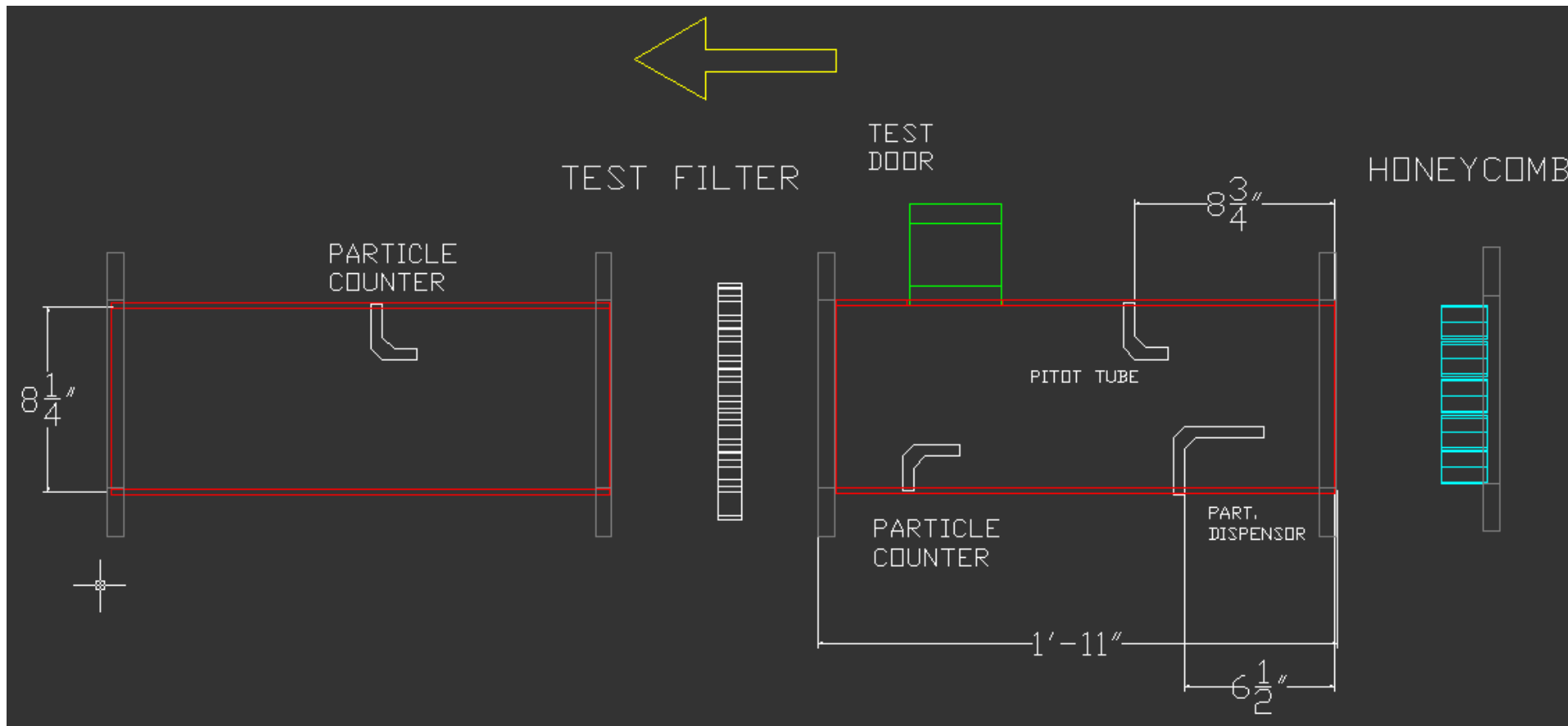


CAD Design





Test Section



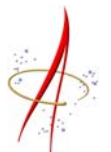


Sensors and Detectors

Particle Detectors

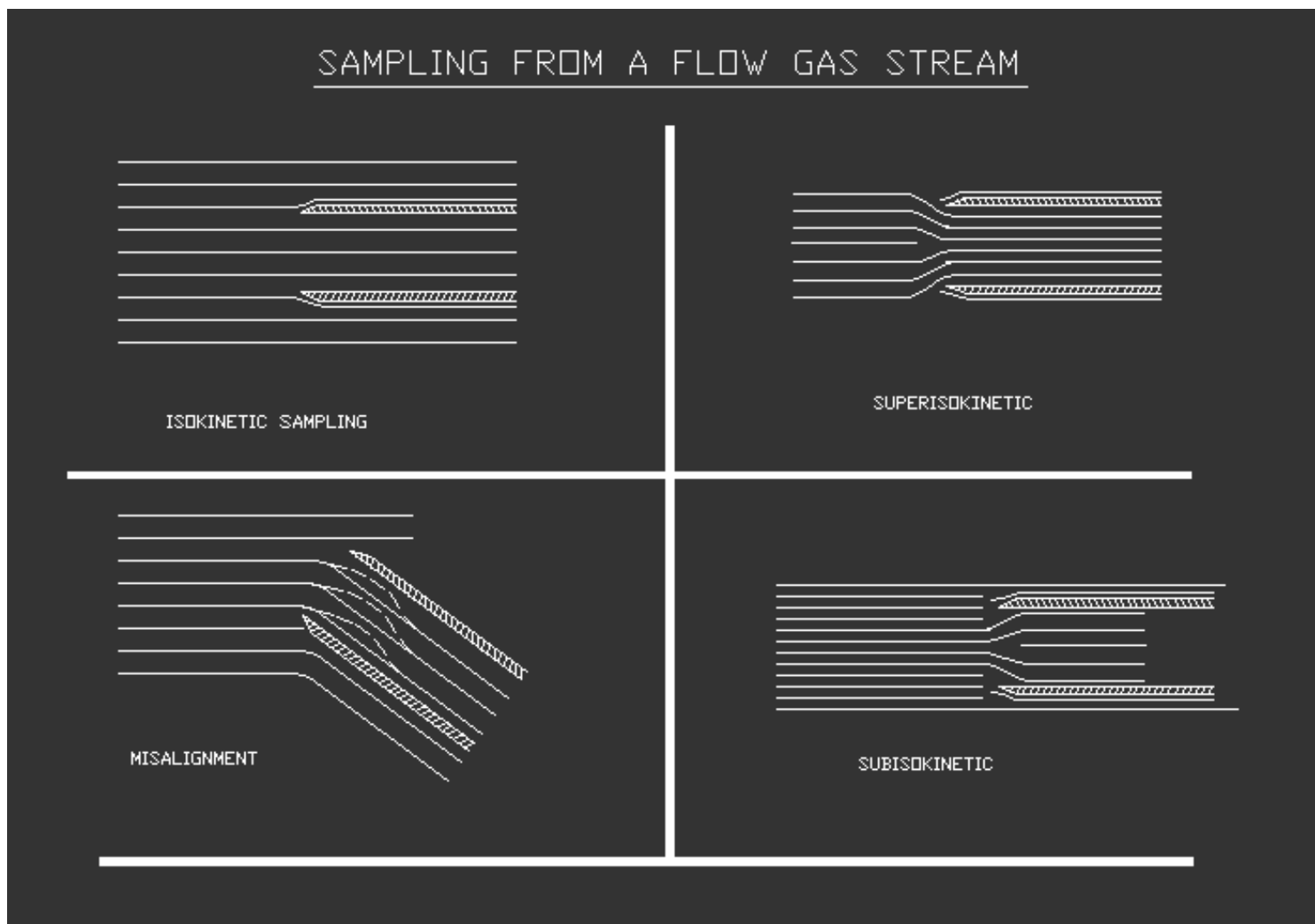
TSI Inc.

- Aerodynamic Particle Sizer (APS) $< 0.5 \text{ } \mu\text{m}$
- Scanning Mobility Particle Sizer (SMPS) $2.5 - 1000 \mu\text{m}$
- Water-based Condensation Particle Counter $10 - 20 \text{ nm}$





Correct Sampling

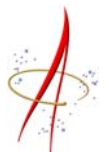




Sensors and Detectors

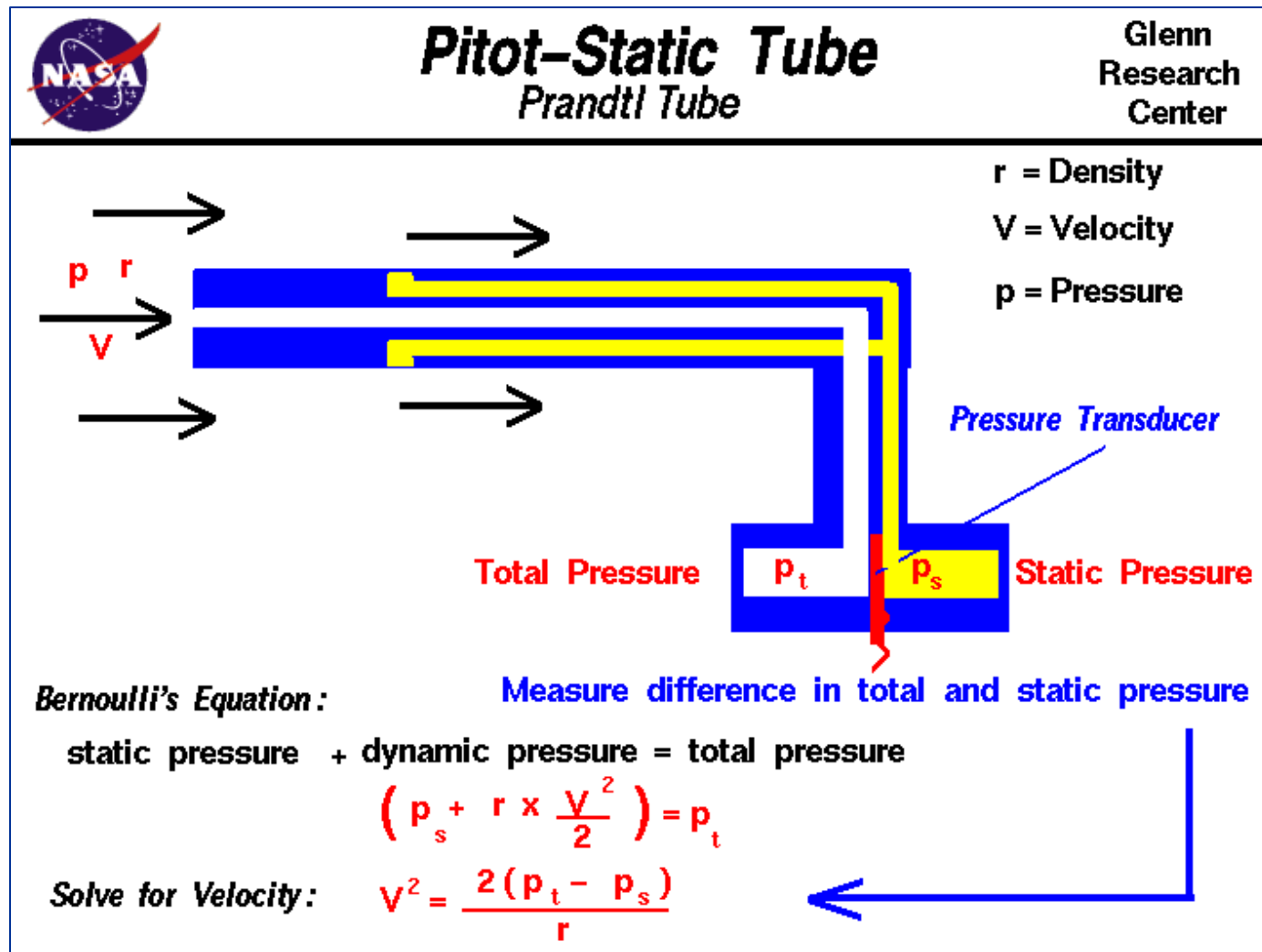
Flow Sensors

- Pressure Transducer
- Pitot tube – is used to measure static and dynamic pressure within the duct.
- Hotwire – measures flow parameters.



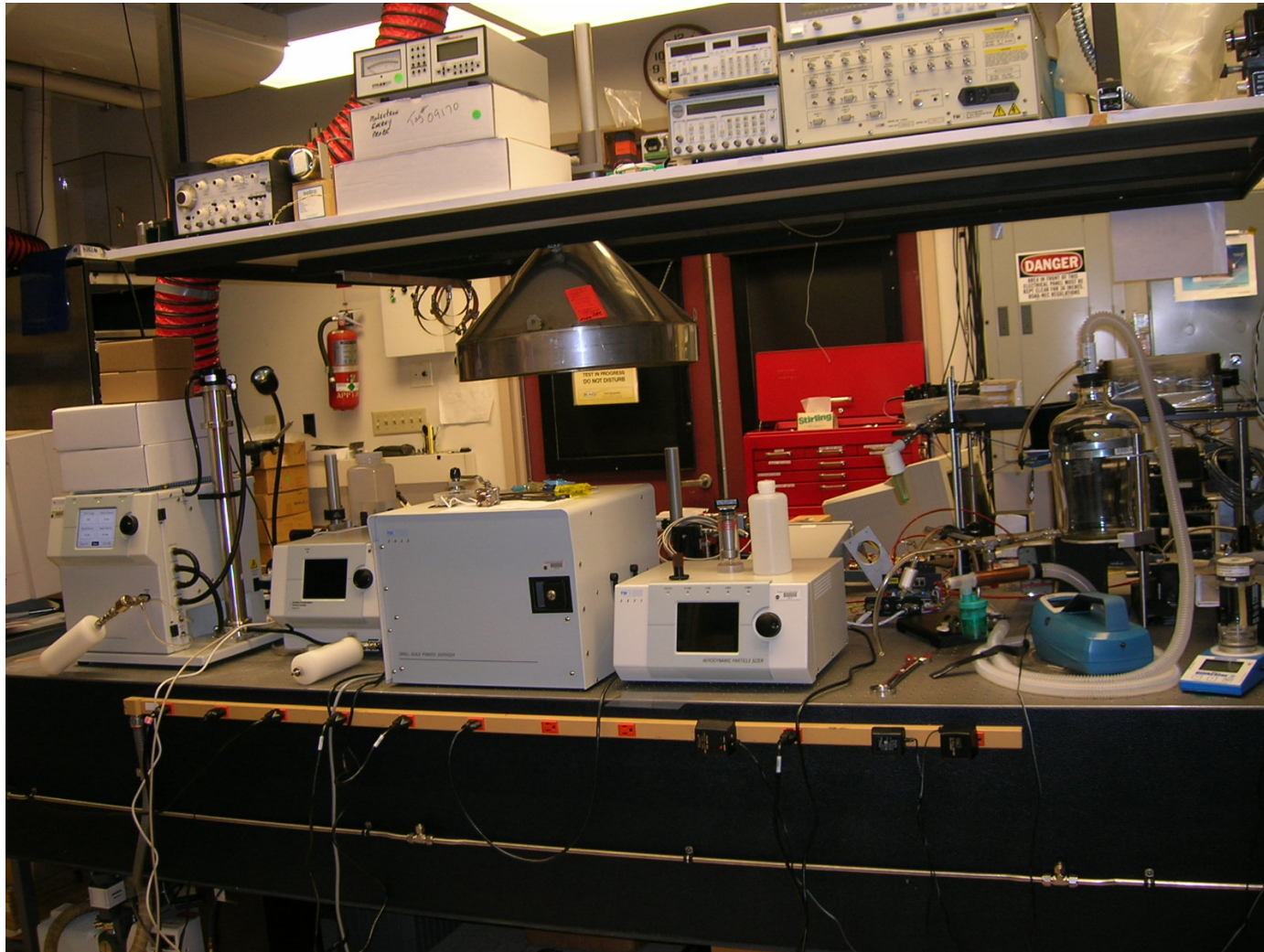


Pitot Tube





Current Lab Setup





Conclusion/Future Work

- Purchase the rest of the probes and instrumentation.
- Finalize design.
- Build the Tunnel.





Acknowledgements

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